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STUDIES IN PSYCHOLOGY AND PSYCHIATRY

FROM THE CATHOLIC UNIVERSITY OF AMERICA

EDITED BY

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PROFESSOR OF PHILOSOPHY

IN COLLABORATION
WITH

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FRANCIS AUGUSTINE WALSH

THE REASONING ABILITY OF CHILDREN IN THE FIRST YEARS OF SCHOOL LIFE

BY

DOM THOMAS VERNER MOORE

THE WILLIAMS & WILKINS COMPANY
BALTIMORE, U. S. A.

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INTRODUCTION

The present little study had its origin in an attempt to investigate the intercorrelation of symptoms in the psychoses. In this investigation it was found necessary to measure in some way the degree of defect of reasoning. No tests were found which could be looked upon as specific tests for reasoning and which at the same time descended low enough to grade the very marked defects of reasoning sometimes present in the psychoses.[1]

With this in view a preliminary trial has been made of the tests here presented[2] which were first given to a number of psychotic patients. They seemed to be serving their purpose fairly well, but it was thought necessary to have some idea of their value in terms of normal intelligence. The tests had been originally formulated to measure the presence of defects of reasoning and it was supposed that most adults of average intelligence would approximate a score of one hundred per cent correct. It was, therefore, deemed important to get the scores of young children so as to have some idea of the relative standing of patients whose score approximates zero.

With this problem in mind, I approached Miss Jessie La Salle, Assistant Superintendent in charge of Educational Research in the Public Schools of the District of Columbia. She went beyond the permission I had hoped to obtain and had her assistants administer the tests individually to two hundred and five children in the first to the sixth grades. In order to obtain scores approximating normal intelligence at the various ages, the group was selected so as to embrace children with an IQ between 90 and 110. These intelligence quotients in 144 cases were based on the Stanford Revision Test and in the remainder on an average of at least two, sometimes three group intelligence tests. The dates of birth were all verified by reference to the Health Department, birth cer-

[1] Burt's tests are the best; but even these are a little above many of the insane.

[2] Most of them were invented for the purpose. A few were adapted from Wrinch.

tificates, passport records and the like, so that they may be trusted as accurate.

My thanks, therefore, are due in a most special manner to Miss La Salle and her assistants and to the Department of Education of the District of Columbia.

The tests are valuable as the norms will show, not only for the original purpose for which they were intended, but also for a preliminary survey of the reasoning ability of children in the first years of school life and it is for that purpose that they are now published.

CHAPTER I

Historical Note on Tests of Reasoning

As early as 1910 Bonser[1] published a monograph on the reasoning ability of children. He employed arithmetical problems (I–II); sentence completion tests (III A); cancellation of the wrong word in a pair printed one over the other in a sentence (III B); opposites test (IV); selection of proper reason for a given statement (V); selection of good definitions (VI; interpretation in ordinary language of two stanzas of poetry (VII); and as a control, spelling.

He felt justified in saying on the basis of his intercorrelations:

> "Among these several varieties of reasoning ability, there is sufficiently high correlation further to verify the conclusion that they are all of one general species of ability, complex though it is.
>
> "The best test among those here used for this general ability is test IV, that of opposites; the next that of the form of selective judgment in test V; and third, tests I–II, the mathematical tests. The poorest is test VII, the interpretation of poems." (p. 105.)

In 1916 he made an investigation[2] of the children tested in 1910 and found that his reasoning tests were capable of predicting High School ability.

In 1914 Robert C. Moore published[3] a note on a piece of research, the object of which "was to demonstrate the close relations between intelligence and the results of tests involving processes of reasoning or its essential elements" (p. 684).

The author used 25 tests on 65 boys and 31 girls. The children belonged to the same form and the age range was one year.

[1] Bonser, Frederick G. The Reasoning Ability of Children of the Fourth, Fifth and Sixth School Grades. Teachers College, Columbia University, New York, 1910.

[2] Bonser, Frederick G. The Selective Significance of Reasoning Ability Tests. The Journal of Educational Psychology 1916, VII, 187–200.

[3] Moore, Robert C. Tests of Reasoning and their Relation to General Mental Ability. Report of the British Association for the Advancement of Science. 1913, London, 1914, 684–685.

"In the main research the reliability coefficients with few exceptions range from .70 to .88. The correlations with intelligence for the better attested tests of reasoning (Opposites, Analogies, Syllogisms, Arguments) provide the highest correlations, ranging from .47 to .74. . . . . On drawing up hierarchies and employing the method of multiple correlation and other criteria it seems clear that the correlations are determined chiefly by the presence of elements essential to reasoning." (p. 685.)

I have not located a more extensive account of this piece of work.[4]

In 1914 Winch[5] published a report on his reasoning tests. Figures were given to show:

(1) That the tests correlate fairly well with age.

(2) That the results correlate much more closely with mental proficiency as indicated by school 'standards' or 'grades' than with age.

(3) That there is a considerable difference in reasoning ability in schools attended by children of different 'social classes.'

(4) That the difference between boys and girls in non-numerical reasoning appears small and doubtful, the balance of advantage inclining toward the boys.

(5) That the pedagogical proficiency of the schools has but slight and indirect bearing upon the results of tests like these.

In 1921 Winch[6] presented an extended study of the reasonings of children, giving in extenso their answers to only four reasoning problems. We have seen only the first three articles. These do not give a set of reasoning tests suitable to grading reasoning ability.

In a miscellaneous group of tests involving also memory and "Analogies" and "Completion" Wyatt found in 1914[7] that "the Analogies and Completion Tests give the highest correlations with

[4] Cf. also Moore, Robert C. Age Scale Methods of Measuring Children. Journal of Experimental Pedagogy, 1919, V, 78–97.

[5] Winch, W. H. Additional Reasoning Tests Suitable for the Mental Diagnosis of School Children. Report of the British Association for the Advancement of Science (At Birmingham, 1913) London, 1914, Pp. 685–687.

[6] Winch, W. E. Children's Reasonings: Experimental Studies of Reasoning in School Children. Journal of Experimental Pedagogy. 1921, VI, 121–141, 199–212, 275–287.

[7] Wyatt, Stanley. The Quantitative Investigation of Higher Mental Processes. The British Journal of Psychology, 1914, VI, 109–113.

the subjective estimation of intelligence. He also found that the intercorrelations admitted of an hierarchical arrangement and that so the theory of the General Common Factor received further support.

In 1914 Dockerill and Fennings[8] devised a reasoning test which consisted of ten proverbs. The task consisted (*a*) in giving a concrete illustration of the problem, (*b*) in forming a statement in ordinary language setting forth as clearly as possible the meaning of the proverb. Answers were scored with regard to clarity from 1 to 10, giving a maximum possible score of 100. Seven classes of boys and two of girls were tested. (Elementary: III, one class; VI, one class; VII, four classes. Secondary: V a, V b, V c, one class each.) There were from 20 to 39 pupils in each class, their average ages ranging from 10.0 to 14.8 The correlation with intelligence as measured by class standing, examinations and teachers' estimations ranged from .55 to .83.

The proverbs used were:

1. All that glitters is not gold.
2. The early bird catches the worm.
3. A stitch in time saves nine.
4. Too many cooks spoil the broth.
5. Make hay while the sun shines.
6. Birds of a feather flock together.
7. Straws show which way the wind blows.
8. A new broom sweeps clean.
9. A bird in the hand is worth two in the bush.
10. Cats in mittens (gloves) catch no mice.

Lindworsky found[9] that ten year old children were capable of solving syllogistic problems. "There can be no question with them," he says, "of learning and exercise. One can, therefore, well say: the carrying out of a simple syllogistic exercise is a thought operation natural to the mind, for which ten year old children already possess the requisite abilities." (p. 222.)

In a footnote he refers to the work of Albert Gut, which we have

[8] Dockerill, W. H. A. and Fennings, A. J. A New Test of Reasoning. The Journal of Experimental Pedagogy, 1914, II, 357–361.

[9] Lindworsky, Johannes. Das schlussfolgernde Denken Freiburg, 1916, XVI + 454.

not seen (Ueber die geistige Entwicklung des Schulkindes. Erläuterungen zu den Arbeiten des Psychologischen Laboratoriums der Universität Zürich von Prof. G. F. Lipps. Zürich, 1914). Gut found a logarithmic curve of development for logical ability from the age of eight to that of fifteen.

In 1917 Kelley published[10] two forms of the completion test that correlated with each other .900. Correlation (with speed and accuracy rated) with Scholastic Standing was .873.

The best test of reasoning so far available was published in 1919[11] by Cyril Burt. It consists of 50 problems ranged in order of difficulty and grouped for chronological ages ranging from seven to fourteen inclusive. The fifty problems chosen are the more satisfactory of a group of 250 questions. The reliability of the test is high, the correlation between averaged marks for the odd and even numbers is .93. With an unselected group of eleven year old children the correlation with intelligence is .81. Standards were also given for the ages from seven to fourteen. A system of graded markings for each response was adopted.

An unsatisfactory attempt was made in 1921[12] by Fairgrieve to adopt Burt's reasoning test to group examinations.

In 1923[13] Winch proceeding on the assumption that transfer in training means the identity of the underlying ability gave a group of children preliminary tests in solving problems in arithmetic and logic. They were then divided into 2 equal subgroups. One subgroup was then practiced from February to June in solving arithmetical problems, the other was given no practice.

Average of the unpracticed group before final test	34.8
Average of the unpracticed group after final test	38.8
Improvement	4.0

[10] Kelley, Truman L. Individual Testing with Completion Test Exercises. Teachers College Record, 1917, XVIII, iv, 371–382.

[11] Burt, Cyril. The Development of Reasoning in School Children. The Journal of Experimental Pedagogy 1919, V, 68–76, 121–127.

[12] Fairgrieve, M. MacCallum. A Mass Test with Mr. Cyril Burt's Intelligence Questions. The Journal of Experimental Pedagogy, 1921, VI, 27–33.

[13] Winch, W. H. The Transfer of Improvement in Reasoning in School Children. The British Journal of Psychology (General Section) 1923, XIII, 370–381.

Average of the practiced group before final test	35.0
Average of the practiced group after final test	49.5
Improvement	14.5

It is thus seen there was evident and marked transfer of training. This should lead us to infer that something that reasons received this training and gives us a right to speak of a faculty of reasoning.

In 1926 A. Barbara Dale[14] published a group test of reasoning ability based on Burt's work. Her test might be used with children from 10 to 16 years of age. It does not descend low enough for use with the insane.

The most recent attempt at a test for reasoning ability is that of Vance,[15] but it is for college students.

Piaget has given us a very interesting study of Children's reasonings, but his results have not been extended to a quantitative estimation of reasoning ability in children.

It would seem from our own results that he probably places the age of onset of the formulation of general principles and deductive reasoning somewhat too late.

"This absence of conscious realization explains why the child only reasons about particular cases. Since the schema is the only general element in childish ratiocination, and since the schema remains unconscious, the child will become aware only of the discrete objects which occupy his mind. Thus the study of 'because' in logical justification showed that even when the child tries to prove his statements, he appeals neither to laws nor to general rules but to singular and specific reasons: 'The little cat ate the big dog.' 'The little cat is little and the big dog is big.' 'On the way there the road goes up,' etc. Furthermore, this was confirmed by an examination of the deductions introduced by the word 'then.' The deduction moves from one individual case to another: 'Then I shall be alone.' 'Then it is inside out,' etc. Finally, our study of discordance indirectly confirms the same law. If children never make use of explicit discordance and do not understand implicit discordance until after the age of 7–8 this is obviously because the notion of an exception to a rule which is presupposed in the notion of discordance between cause and effect is not a primitive notion and is not one that is familiar to them. For there to be excep-

[14] Dale, A. Barbara. Group Tests in Reasoning Ability. British Journal of Psychology (General Section) 1926, XVI, 314–338.

[15] Vance, Thomas F. The Iowa State College Reasoning Test. University of Iowa Studies in Psychology. Psychological Monographs, 1928, XXXIX, 2, pp. 72–77.

tions, there must obviously have been rules, and if the child fails to understand the fact that there are exceptions, it must be because he never has formulated any rules.

"The consequence of this fact that the child's formulated thought only takes place in connection with particular or specific cases is that we cannot speak about deductive thought as such before a very advanced stage of development. For deduction presupposes general propositions, whether these serve to characterize the individual objects with which the reasoning process is concerned, or whether they constitute the aim which the process of deduction has set out to reach. Now the motor schemas of which we were speaking just now cannot do the work of general propositions, and what prevents them is the fact that they do not confront one another in the subject's consciousness and thus give rise to syntheses and oppositions which alone would favor the appearance of logical addition and multiplication.

"Provisionally, therefore, we have established three points: absence of conscious realization (prise de conscience), absence of general propositions, and absence of deduction." (pp. 56–7.)[16]

We should rather say that at the age of seven to eight children are just commencing to formulate their general principles in words. That some children at this age can use general principles is evident from the results given below. It is probably a period of formation of simple principles of reason and conduct which will be used mechanically in the years to come.

[16] Piaget, Jean. Judgment and Reasoning in the Child. New York, 1928, Pp. viii + 260.

CHAPTER II

The Tests as Administered and Scored

The tests were administered in the order in which they are presented below. There are three classes of tests: I, Reasoning; II, Autistic Fallacies; and III, Logical Fallacies. The first group presents a number of simple problems and calls for an answer and then a reason for the answer given. The two following groups present an argument and ask whether it is correct or incorrect and why. The second group is termed "autistic fallacies" because the arguments are similar to the peculiar type of bizarre reasoning sometimes manifested by the insane. The third group presents some very simple arguments in ordinary logical form, some of which are correct, others incorrect.

In scoring no account was made of whether the child's answer was correct or incorrect. He was credited with an answer only when he gave a satisfactory reason.

After each test we give the principle underlying the scoring and an example of a correct and an incorrect response. In giving the tests to the children, the examiner had a mimeographed form and wrote the answer in a space provided for it. In giving the tests to the insane, this was dispensed with and the answer written down after its appropriate number on a sheet of blank paper.

I. REASONING TESTS

(1) *If you were hungry and wanted to get your dinner, would it be more reasonable to go to a hardware store or a restaurant?* Why?

Any reason was scored correct which showed that the child understood that whenever you want to get anything you must look for it in the proper place and that the proper place to look for a dinner is in a restaurant and not a hardware store.

Correct: Go to a lunch room, 'cause they eat there.

Incorrect: Restaurant, 'cause it ain't so far. Restaurant 'cause you could rest there.

(2) *Which is worse to do—steal a nickel or steal $500?* Why?

Any answer was scored correct that implied the greater the damage done, the greater the wrong. Those, therefore, who said it was just as bad to steal a nickel as to steal $500 were marked wrong.

Correct: Steal $500 because that's more money.

Incorrect: Don't steal. Don't steal no dollars. 'Cause they'll put you in jail if you steal.

(3) *Which should a woman take out on a rainy day, a parasol or an umbrella?* Why?

Any answer was scored correct which implied that the child understood that those who go out on a rainy day must go prepared so as not to get wet and that an umbrella is suitable for the purpose.

Correct: An umbrella for the rain, so the rain won't get all over you.

Incorrect: Umbrella, 'cause it's the best thing.

(4) *If a man wanted a prescription filled for medicine the doctor ordered, would he be likely to get it in a garage? Where should he go?* Why?

Any answer was scored correct which indicated that the child knew that medicine was not to be obtained at a garage but at a drug store or from the doctor himself.

Correct: No, at the doctor's office or at a drug store.

Incorrect: The doctor would bring it to him because he don't have to walk that far and the doctor has.

(5) *Would a Democrat or a Republican be more likely to get a political job from a Democratic President?* Why?

A correct reason for the answer to this question required the child to understand the principle that one is more likely to receive assistance from friendly associates than from others.

Correct: A Democrat, because if it was a Democratic President, he was on the same side. Like a soldier in the same way would get more favor in his army than the enemy's.

Incorrect: Yes because he knows more things to do.

(6) *Some boys wanting to have a lark rolled a watermelon away from an old Italian's fruit stand and seeing that they could run faster than the Italian, made off with the melon. Did they do right or wrong?* Why?

Any answer was scored correct that implied that the act was wrong because it was stealing.

Correct: Wrong because they ought not to steal it.

Incorrect: Wrong because it ain't right to roll a watermelon down hill—ought to roll eggs.

(7) *If all horse-chestnut trees grow buck-eyes and my neighbor is going to plant a horse-chestnut tree in his yard, can I be sure that it will grow buck-eyes?* Why?

Any answer was scored correct that implied that what is true of the class is true of the individual that belongs to it.

Correct: Yes, because you said *all* grow buck-eyes.

Incorrect: No, because sometimes they don't get enough sun.

(8) *If all the fish in the world have gills, can I be sure that the fish in Alaska will have gills?* Why?

Score according to the same principle as (7).

Correct: Yes, because Alaska is in the world.

Incorrect: No ma'am, 'cause some of them are babies and they don't have them.

(9) *If no poison does one harm if taken in small enough amounts, can I be sure that the poison—Carbolic Acid—will do me no harm if a small enough dose is taken?* Why?

Any answer was scored correct that pointed out the conditions laid down: if a small enough dose is taken.

Correct: Yes, 'cause it said that the poison would do no harm if a small enough dose were taken.

Incorrect: The poison will do harm, because if poison wouldn't do harm—it kills people, poison does.

(10) *If equals are added to equals, must the whole found by such addition be equal?* Why?

For a correct response it was only required that the child should express the idea that equals plus equals must be equal.

Correct: Yes, because equals and equals make equals.

Incorrect: No, 'cause equal ain't addition.

(11) *If unequals are added to unequals will you always have unequals as a result?*

For a correct response it was required that the child should point out that unequals added to unequals might compensate each other and make equals.

Correct: No, because you might get equals.

Incorrect: Not always, because 3 and 3 make 6 and you have 6 as an equal.

(12) *Do you think that a nickel is bigger around than a dime or smaller, or the same size? Suppose you had a nickel and a dime and nothing else to measure with.—How could you find out?* Why?

Any answer was scored correct that implied that this could be found out by putting one on top of the other. Measuring with a ruler was also regarded as correct, notwithstanding the wording of the problem.

Correct: Put 'em together.

Incorrect: Nickel is bigger, dime is smaller, 'cause, dime is smaller.

(13) *Mary sowed some seeds in some flower pots and every few days she watered them. Johnny said that he did not see that putting water on the seeds did any good. Could Mary, or could she not, prove that watering made the seeds grow faster?*

(Wait for Answer: If "yes," ask, How? If "no," Why not?)

Only those answers were considered correct that pointed out a definite comparison made by growing one plant or set of plants and watering them and another without watering, or by first watering a plant and then stopping and watch it die.

Correct: They could plant some seeds the same time. She could put water on hers and he wouldn't and they could see which would grow the faster.

Incorrect: If she hadn't put the water on they might not have grown.

(14) *Harry and Tom start at the same time from their houses at opposite ends of a long street, and run to meet each other. Tom runs faster than Harry. Will they meet in the center or nearer to Tom's house or farther from it?*

Any answer was considered correct that implied that Tom would pass the center and get nearer to Harry's house because he could run faster.

Correct: They will meet further from Tom's house because he runs faster.

Incorrect: Further from it because they didn't run that way.

II. AUTISTIC FALLACIES

(1) *If I had a thousand dollars, I could satisfy my heart's desire.*
But I must satisfy my desires.
Therefore, I have a thousand dollars.

Is this argument correct or incorrect?

Any answer was considered correct that implied that the child understood that desires need not be satisfied in reality no matter how strong they may be to the one who experiences them.

Correct: Incorrect, because lots of people satisfy themselves with pretty near nothing.[1]

Incorrect: Wouldn't have a thousand dollars very long because you would spend it.

(2) *If one washes he cleanses himself from dirt.*
If one sins, he is dirty.
If one washes he cleanses himself from sin.

Correct or incorrect.

Any answer was considered correct that pointed out the distinction between bodily uncleanliness and moral guilt.

Correct: Incorrect. You can wash your face, but it isn't going to cleanse yourself from sin.

Incorrect: Correct, because if you commit a sin and you wash your hands to take the sin away, I think it would go away.

[1] This is the only example in our material of an answer considered correct. The child was a boy of 11 years 4 months, in sixth grade. His IQ was 106.

(3) *One who does wrong helps toward the destruction of the country.*
I have done wrong.
Therefore I am responsible for the destruction that is coming on the world.

Correct or incorrect?

Any answer was considered correct that pointed out the disproportion between one individual's wrong and the destruction of the whole world.

Correct: Incorrect, because you might not have done so very wrong. It depends on how wrong you did. If you make little mistakes, it isn't so bad.

Incorrect: Correct, because if you do bad, God keeps that and makes bad luck come on the world and makes the world come to an end.

(4) *If one is like another in a great many points, he is the same thing as the other.*
But a man I know has the same duties to take care of the country as the President, he thinks like him and looks like him.
Therefore this man whom I know is the President.

Correct or incorrect?

Any answer was considered correct that implied that the child knew that no matter how much two people resembled each other, they could not constitute one individual.

Correct: Incorrect because you might be speaking of the same man. No two in the world are alike. There is only one person like the president, that is himself.

Incorrect: Correct, because if he thought and did and looked like him he'd naturally be president. Ought to be anyhow.

III. LOGICAL FALLACIES

(1) *A little boy was told that all worms crawl.*
The next day he saw another little thing crawling and told his sister it was a worm.
Was he right in saying this, in view of what he was told the day before? Why?

Any answer was considered correct that pointed out that it might be any of various crawling things.

Correct: He might have been and he might not, because it could have been a snake.

Incorrect: Yes Ma'am because worms really do crawl. If anybody says worms don't crawl, they are mistaken.

(2) *I once read that some mushrooms were poisonous.*
Should I refuse to eat any mushrooms in the future? Why?

Any answer was considered correct that pointed out the difference between some and all.

Correct: No, he said some of 'em aren't.

Incorrect: No ma'am, because you won't know which is poison.

(3) *I know that to drive my auto too fast is dangerous.*
Would I be in danger if I drove ten miles an hour? Why?

Any answer was considered correct that implied that ten miles an hour would not be fast.

Correct: No, because that ain't fast.

Incorrect: No, because you ain't supposed to ride fast.

(4) *All automobiles have four wheels.*
Here is a vehicle with four wheels.
Therefore it is an automobile. Why?

This was marked according to the same principle as (1).

Correct: It might not be an auto, it could be a carriage.

Incorrect: Correct because an automobile really has four wheels. I never saw an automobile without four wheels.

(5) *All cities have street cars.*
Baltimore is a city.
Therefore Baltimore has street cars. Why?

Any answer was considered correct that pointed out that what is true of the class is true of an individual pertaining to the class. Reaffirmation of the minor was marked incorrect.

Correct: True, 'cause if all cities have street cars and Baltimore is a city, it has street cars.

Incorrect: Correct, because Baltimore has got street cars.

(6) *All children should go to school.*
John is a child.
Therefore John should go to school. Why?

Marked as (5). But denials were counted correct that were conditioned on the possibility of John's being too young.

Correct: Correct because he is a child too.

Incorrect: He ought to learn something.

(7) *Every triangle has three sides.*
This figure has four sides.
Therefore it is not a triangle Why?

Answers were scored correct that pointed out that a figure with four sides could not be a triangle.

Correct: Something with four sides is not a triangle.

Incorrect: I don't think it would have to be a triangle to have three sides.

(8) *The sum of 9 and 12 is 21.*
The sum of two numbers is 21.
Therefore the numbers are 9 and 12.

Any answer was considered correct that pointed out the fact that the sum of various other numbers equals 21.

Correct: There could be other numbers to make 21.

Incorrect: Correct because 9 and 12 "is" 21.

CHAPTER III

Age and Grade Norms

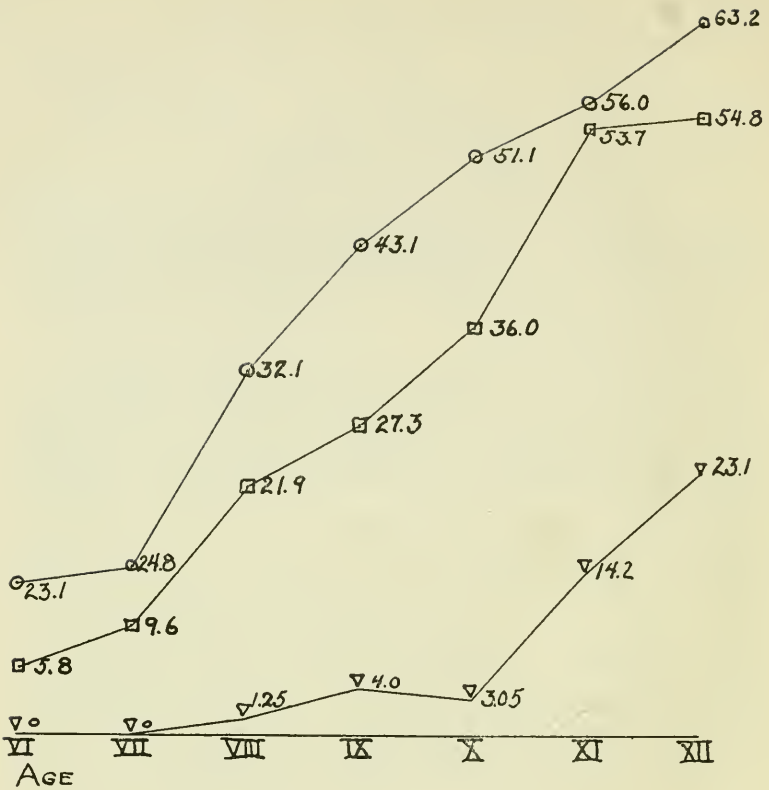
The averages for ages and grades are given in the accompanying tables and figures. In drawing the figures the scores have all been reduced to percentages of the maximum possible score in each type of test so that progress from year to year would be given on a comparable scale.

From the curves it is evident that the tests for reasoning and logical fallacies give a fair differentiation of ability both on the basis of age and grade. The test for ability to detect autistic fallacies is just commencing to develop as we get to the upper limit of our group.

We must remember, however, that we have used no test to partial out language ability. The vocabulary scores in the Stanford test might have been called upon to throw some light on the extent to which our reasoning tests depend upon the ability to understand spoken language; but I did not ask for this separate score in order to determine this point. It is very likely that disability to detect our autistic fallacies was largely dependent on the child's being unable to understand what was said.

The tests were also given as a group test to 103 Freshmen in a girls' college with the following results:

	MEAN RAW SCORE	MEAN PER CENT CORRECT	STANDARD DEVIATION RAW SCORE
Reasoning	12.38	.88	1.32
Autistic Fallacies	3.30	.83	0.92
Logical Fallacies	6.43	.80	1.35



CURVE I. DEVELOPMENT OF LOGICAL ABILITY WITH CHRONOLOGICAL AGE

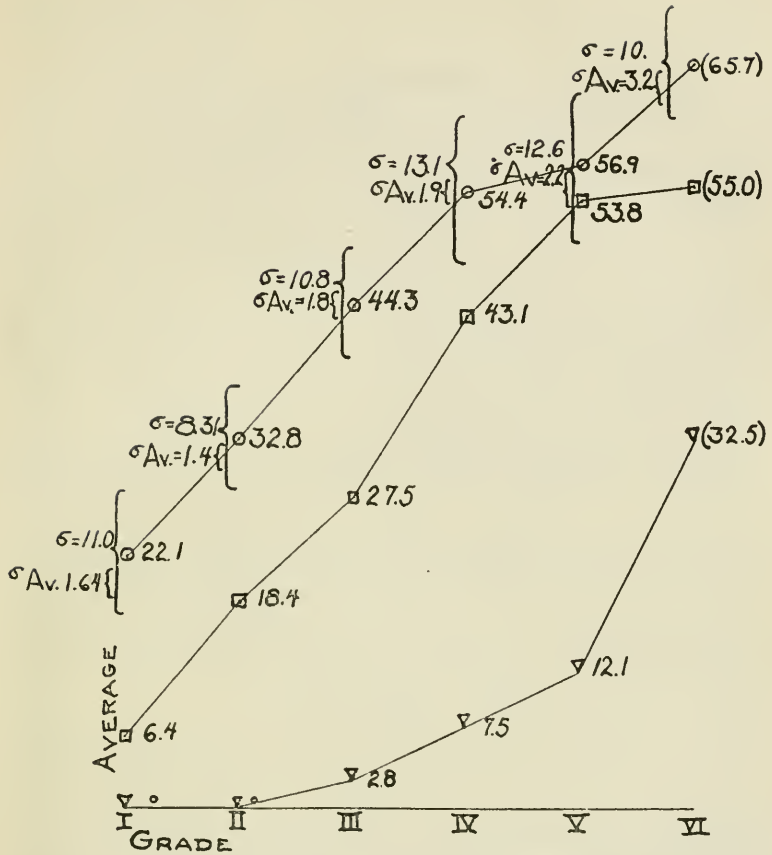
Figures give mean value in terms of percentage of maximum possible score.

TABLE 1

Age norms and their standard deviations for reasoning and logical fallacies

The mean values only are given for Autistic Fallacies

	5:6–6:5	6:6–7:5	7:6–8:5	8:6–9:5	9:6–10:5	10:6–11:5	11:6–12:5
Reasoning Mean.....	3.23	3.47	4.50	6.04	7.15	7.84	8.85
Standard Deviation.....	1.73	1.48	1.36	2.18	1.85	1.75	2.14
Autistic Fallacies, Mean...	0	0	0.05	0.16	0.12	0.57	0.92
Logical Fallacies, Mean....	0.46	0.75	1.75	2.18	2.88	4.30	4.38
Standard Deviation.....	0.63	0.95	1.18	1.51	1.53	2.12	1.64



CURVE II. DEVELOPMENT OF LOGICAL ABILITY WITH SCHOOL GRADE

σ = Standard deviation. σ Av. = Standard deviation of the average. Figures to right of curves give mean values in terms of percentage of maximum possible score.

The reliability of the reasoning test was calculated roughly by dividing the fourteen tests into two approximately equal groups as gauged by their rank in percentage of correct answers for the whole population. On account of the coarseness of grouping involved in correlating the seven step data resulting, the correlation was determined by the average tetrachoric r for two dichotomies. This was 0.75. The reliability then for the whole test is 0.86.

The ascending order of difficulty in the reasoning test is as follows, the starred and the unstarred numbers representing two groups of approximately equal value: 3*, 4, 1, 2*, 6*, 12, 14, 8*, 7*, 9, 5, 10*, 13, 11*.

CHAPTER IV

The Intercorrelations of the Tests

We submit the accompanying tables of correlation arranged in order of the degree of correlation with reasoning. The correlations for autistic fallacies are bi-serial r values obtained by regarding all children as capable of detecting autistic fallacies who succeed in one or more of the four problems given. The others are the ordinary product moment values. The mental age in 144 out of the 205 cases was determined by the Stanford tests, in the rest by an average of several group tests. (See Tables 2 and 3.)

It is evident from inspection that in both tables the hierarchy is somewhat disturbed. This would lead us to expect high tetrad differences. The tetrad differences for the table with chronological age partialled out are: $-.143$, $-.089$ and $.054$. The probable error according to Spearman's Formula is .021.[1] Thus we see that the smallest of these tetrads is twice its probable error and the largest about seven times the probable error. We have therefore no evidence from our present data that one general factor and no group factors underly all these performances.

The correlations between "reasoning," "autistic" and "logical fallacies" is definitely higher than any of these with mental age. This however, is what we should expect. The Stanford Revision and the group tests involve reasoning only to a slight degree; and if there is any such thing as a specific logical or reasoning ability it is clouded by the various other abilities measured in such tests as the Stanford.

That the three abilities can be conceived of as due to one general factor and three specific factors can be maintained as far as the correlations are concerned for they satisfy the criterion proposed recently by Kelley.[2] But the criterion is not rigid and merely shows that there is nothing prohibitory in such a conception as far as can be determined from the correlations. Definite information

[1] The British Journal of Psychology. General Section, 1925, XV, p.19.
[2] Crossroads in the Mind of Man, 1928, pp. 41–43.

on this subject could only be obtained by trying several tests for each specific ability.

Having partialed out chronological age, the second order partial between Reasoning and Ability to detect autistic fallacy with Ability to detect logical fallacies partialled out drops to 0.185. The second order correlation between Reasoning and Logical

TABLE 2

Intercorrelations—whole population

	R	M.A.	C.A.	L	A
R		.714	.712	.711	.648
MA	.714		.882	.682	.333
CA	.712	.882		.653	.456
L	.711	.682	.653		.554
A	.648	.333	.456	.554	

TABLE 3

Intercorrelations—male population with chronological age partialled out

	R	A	L	MA
R		.517	.462	.254
A	.517		.379	−0.016
L	.462	.379		.291
MA	.254	−.016	.291	

Ability with Autistic partialed out remains relatively high, at 0.336; that between "Autistic" and "Logical" with Reasoning partialed out drops to 0.184. These values give some evidence that there is a closer connection between Reasoning and Ability to detect logical fallacies than between either of these and Ability to avoid autistic fallacies.

CHAPTER V

The Mechanism and Principles of Reasoning in Early School Life

I. THE MECHANISM OF REASONING IN THE FIRST GRADE

Let us now attempt to get some idea of the mechanism of reasoning in the first grade. To do this let us look at the reasons given for preferring a restaurant to a hardware store as a place to eat. There were seventeen answers given by first grade pupils that were regarded as correct. Everyone of them was a statement in one way or another of the simple fact that a restaurant is a place where you can get things to eat.

Let us attempt to reconstruct from this the process of reasoning as it occurred in the child's mind. We have the conclusion stated by the child. *You should go to a restaurant.* We have the child's statement of a reason which must constitute one of the premises: *Because a restaurant is where you can get something to eat.* Let us now analyze the data given the child in the formulation of the question and see what other premises were present. The original question was: If you were hungry and wanted to get your dinner would it be more reasonable to go to a hardware store or to a restaurant? From this question we can formulate the first premise thus: *If you are hungry, you should go where you can get something to eat.* Then the fact that the child accepts the task leads us to believe that he implicitly formulates the next premise: *But you are hungry* as you said. The conclusion that flows frum this is: Therefore *you should go where you can get something to eat.* This is the major premise of a syllogism for which all the children, whose answers were considered satisfactory gave this minor: *But a restuarant is a place where you can get something to eat,* as the reason for their conclusion: Therefore *you should go to a restaurant.*

It is interesting to note the fact that as far as conscious formulation of premises in this problem is concerned, first grade children gave expression only to the minor and not to the major.

The second problem was: Which is worse to do, steal a nickel

or steal five hundred dollars? Twenty-three out of forty-five children in the first grade answered this correctly and all gave as their reason the variously stated principle: *It is worse to steal a larger sum of money than a smaller one.*[1] This apparently is a clear statement of the major premise, the minor being the very evident fact that *five hundred dollars is a larger sum than a nickel.* From these premises the conclusion is at once derived: *It is worse to steal five hundred dollars than a nickel.*

The third question was: Which should a woman take out on a rainy day, a parasol or an umbrella? Two types of reasons were given for the answers to this question which may be formulated as follows: (*a*) an umbrella, in order to keep from getting wet; (*b*) an umbrella because it is raining (10 out of the 39 correct responses).

In the first of these answers we have the more significant fragment of the major premise: *All those who go out when it is raining should take an umbrella in order to keep from getting wet.*

In the second we have a statement of the minor premise. But *it is raining when this lady goes out* (or to put it in better syllogistic form: But this lady is going out when it is raining).

From these premises the child draws the evident conclusion: Therefore *she should take an umbrella.*

Only a few brought out the fact of the relative superiority of an umbrella over a parasol and this was not required for the response to be marked as correct.

Question four was answered correctly by 27 or 60 per cent of the first grade pupils. It illustrates the same mechanism as question one.

There were no correct answers to question five.

Twelve of the first grade children said in answer to question six that it was wrong. When asked why, they said either "because they ought not to steal" or more simply "because they stole it."

The full process of reasoning in the child's mind is as follows:

(1) These boys committed an act of stealing. This was per-

[1] All who stated this principle were recorded as having given a correct response. Some gave the principle but answered, e.g. "Steal a nickel because that wouldn't be much." Such answers were regarded as correct on the supposition that the child intended an answer in accordance with the principle he stated.

ceived from an analysis of the question. It is the minor determined here as usual from the facts of the case.

(2) All those who steal do wrong. This was expressed explicitly in answer to the question, Why do you think they did wrong?, by the child's saying "They ought not to steal"—or implicitly by a statement of the essential point in the minor "because they stole it." But this minor implies the subconscious presence of the major: All those who steal do wrong.

(3) The conclusion: Therefore they did wrong. This sentence was expressed by the child by the one word wrong.

The probable order of events in the child's mind is as follows:

(1) Understanding the problem read. This involves analysis and perceiving the relation of the problem to truths already in the child's mind. This may be expressed as the assimilation of the data of a problem to principles acquired in past experience, just as perception may be defined as the assimilation of sensory data to the categories of past experience. The result of this is the formulation of the minor, i.e. these boys stole.

(2) Deduction and expression of the conclusion without any focally conscious formulation of the major premise. The major premise operates often, even in adults,[2] without coming to the focus point of consciousness. Hence it has been claimed that argumentation proceeds from minor premise to conclusion without any major premise at all.

Mill says of Thomas Brown.

"I allude to Dr. Thomas Brown, whose theory of ratiocination is peculiar. He saw the *petitio principii* which is inherent in every syllogism, if we consider the major to be itself the evidence by which the conclusion is proved, instead of being, what in fact it is, an assertion of the existence of evidence sufficient to prove any conclusion of a given description. Seeing this, Dr. Brown not only failed to see the immense advantage, in point of security for correctness, which is gained by interposing this step between the real evidence and the conclusion; but he thought it incumbent on him to strike out the major altogether from the reasoning process, without substituting anything else, and maintained that our reasonings consist only of the minor premise and the conclusion, Socrates is a man, therefore

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[2] Cf. Dunn. The Psychology of Reasoning. Studies in Psychology and Psychiatry, 1926, I, i, p. 94.

Socrates is mortal: thus actually suppressing as an unnecessary step in the argument, the appeal to former experience."[3]

(3) The explicit formulation of the major premise, e.g. "They did wrong." Why? "Because they ought not to steal," (but they did steal. Therefore, they did what they ought not to do, that is to say, they did wrong.) Or the examiner is left to infer the major as self-evident by specifically mentioning the chief point in the analysis giving rise to the minor. "They did wrong." Why? "Because they stole" (and you know all those who steal do wrong.)

The explicit formulation of the major comes only when the child is asked to give a reason for his answer and not always then. For very often as we have seen a minor is given which implies a self-evident major.

Questions seven and eight were intended to bring out the mechanism of inference by the *dictum de omni et de nullo.*

The only correct answers to these questions in the first grade were given by one child.

This child answered questions seven and eight as follows:

(7) Yes. Because the other ones got black eyes, they'll get black eyes.

(8) One fish has got gills, the other one will have gills.

This is, however, a very lame formulation of the "dictum" and does not certainly imply the ability to formulate clearly the principle: If all the members of a class have a certain attribute, this individual who is a member of the class will certainly be found to possess it.

A clearer formulation of the principle of subsumption is found in the second grade. Thus a girl of eight years one month in the second grade answered the question: "If all the fish in the world have gills, can I be sure that the fish in Alaska will have gills?" "Yes ma'am, because you said if *all* the fish in the world."

From this time on it is fairly common to find that a more or less clear formulation of the principle of subsumption of a particular individual under a class as the basic principle of reasoning. In the third question[4] we found a fragment of a major formulated

[3] Mill, J. S. A System of Logic, New York, 1887, Book II, Chap. ii, pp. 151–2.

[4] Cf. supra, p. 21.

which if fully expressed would have been a universal premise under which the minor was subsumed as a particular case. Though this was the essential mechanism the actual formulation of the universal major with its particular minor was not accomplished by any of our forty-five first grade children.

There were no correct answers in the first grade to questions nine, ten and eleven.

Question twelve was answered correctly by fifteen out of the forty-five first grade pupils. It does not require a process of reasoning in the logical sense but merely a technique of observation. The ability to answer it correctly, however, involves some of the essential elements in the reasoning complex, viz. to analyze a problem and understand its meaning and then make use of the principles of past experience in solving it.

There were no correct answers in the first grade to question thirteen.

Question fourteen was answered correctly and the correct reason given by six or 13 per cent of the first grade pupils. Its chief difficulty is one of analysis. It requires of necessity no logical reasoning but can be solved by clear visualization and the utilization of past experience in regard to fast and slow moving objects. As to the actual mechanism of the process we can get no certain information from the answers of the children.

II. THE MECHANISM INVOLVED IN AUTISTIC FALLACIES

There is no case of either acceptance or rejection of the autistic fallacies in either the first or second grade.

Rejection of the autistic fallacies occurs first in the third grade by four children out of thirty-six. These four ranged from eight years four months to nine years four months in chronological age and from eight years four months to nine years three months in Stanford mental age.

Clear acceptance of the autistic fallacies occurred as given in Table 4.

From a comparison of Curves I and II and this table it would appear that the logical ability to criticize and reject autistic reasoning has a tendency to appear somewhat before the tendency to fall into this type of reasoning.

All the reasons given show that the conclusions are based upon a pathological major. Pathological is here used in the sense of a false premise that has no basis in logical common sense.

Autistic reasoning[5] from our study is seen to make its earliest appearance at about ten years whether measured by the chrono-

TABLE 4

Early stages of autistic reasoning

GRADE	FAL-LACY	CA	MA	SEX	REASON
IV	2	9.8	9.8	G	Correct. Because if one washes when he is dirty; why he is all clean. And if he washes when he has sins, his sins will all go away.
V	2	10.7	12.0	G	Correct. Because if one washes, maybe it will wash away his sins.
V	2	11.5	10.8	B	Correct. Because when one washes, he washes himself from sin and makes himself clean too.
V	2	12.0	11.6	G	Correct. Because if he washes he cleanses himself from sin.
V	2	12.3	12.3	G	Correct. Because the Bible says so.
V	3	10.8	10.11	B	Correct. Because if you do bad, God keeps that and makes bad luck come on this world and makes the world come to an end.
VI	2	10.0	10.0	G	Correct. Because if you commit a sin and you wash your hands to take that sin away, I think it would go away.
VI	2	11.7	12.3	G	That's correct. If one washes, he takes off the sin.
VI	2	11.9	12.5	G	Correct. If one washes, he takes away sin and dirt.

logical scale or that of the mental age. It is preceded by the ability to reason in a logical manner and to detect logical fallacies as is evident from Curves I and II.

[5] "Autistic reasoning" means here, of course, the tendency to draw conclusions based on a pathological major. The ability to detect autistic fallacies commences to develop according to our data somewhat earlier.

TABLE 5

Early Stages of Logical Criticism

NUMBER OF CHILD IN SERIES	FALLACY	CA	MA	SEX	REASON
9	1	6.4	6.6	B	Every time he sees something crawl, it does not have to be a worm.
44	1	6.4	6.6	B	Maybe it wasn't a worm. Maybe it was a lizard.
20	1	7.1	7.4	B	It might have been a snail.
15	1	7.2	7.8	B	'Cause it was a bug. A bug can crawl. So can a bee.
43	1	7.3	7.6	B	It might have been a bug.
6	3	6.2	6.2	B	Because you wouldn't be driving fast.
14	4	7.1	7.10	B	Because it might have been a wagon.
7	5	6.3	6.3	G	Because all the cities have street cars.
25	5	6.5	6.3	B	Because it has street cars in every city.
32	5	6.7	7.3	G	Because all cities do have street cars.
21	5	6.10	7.1	B	Because they have street cars every place.
19	5	7.1	7.1	B	All cities have street cars.
20	5	7.1	7.4	B	Because all cities have street cars.
11	6	6.6	7.1	B	Because *all* children should go to school
32	6	6.7	7.3	G	Because all children should go to school.
22	6	6.8	6.8	B	Everybody should to to school. They ought to.
10	6	6.9	6.9	G	If he is a child, he should go to school.
1	6	7.10	7.6	B	'Cause everybody's supposed to go to school so he can learn.
2	6	8.8	8.1	G	'Cause everybody's supposed to go to school, if he is a child.
1	7	7.10	7.6	B	Because every triangle has three sides. Triangles haven't got four.
7	7	6.3	6.3	G	That's wrong. That figure has four sides.
11	7	6.6	7.1	B	It isn't a triangle 'cause—triangle doesn't have four sides.
19	7	7.1	7.1	B	If it had four sides, it wouldn't be a triangle.
32	7	7.2	7.11	G	Because it has got four sides.

III. THE MECHANISM INVOLVED IN THE DETECTION OF LOGICAL FALLACIES

The accompanying schema gives the reasons alleged by first grade pupils for the logical fallacies which they detected. From the point of view of logic the most interesting of our fallacies is the first. Five of the forty-five first grade children gave clear evidence that they could see through the fallacy of the undistributed middle and give clear expression to the reason why the argument was false. When, however, the same type of fallacy was presented in ordinary syllogistic form, none of these same children could say why it was wrong and only one in this total of forty-five first grade pupils detected the fallacy and pointed out the reason why.

It is, therefore, evident that at the dawn of school life some children are already able to analyze an argument and state why it is false. This ability, however, is not as yet adequate to all or even most occasions and they readily slip into error.

What is this ability in question? As it appears in the answers given to why, under fallacy number one, it seems to be connected with the power to recall exceptions out of the fund of the child's past experience. It might have been a lizard, a snail, a bug, a bee. These things crawl and still they are not worms. Only one of the five who saw through this fallacy expressed his answer purely in general terms. But if one child of six can do this, it is likely that the power to generalize experience is already developing at this age. The germs of the laws of the syllogism are already unfolding at the dawn of school life.

As Burt says:

> "All the elementary mental mechanisms essential to formal reasoning are present before the child leaves the infants' department, i.e., by the mental age of seven, if not somewhat before. Development consists primarily in an increase in the extent and variety of the subject-matter to which those mechanisms can be applied and in the increase in the precision and elaboration with which those mechanisms can operate."[6]

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[6] Burt, C. The Development of Reasoning in School Children. Journal of Experimental Pedagogy, 1919, V, p. 127.

CHAPTER VI

Relation of Findings to Logical Theory

It will be of some value to make use of our insight into the dawn of logical ability in childhood to see how it tends to confirm or disprove the theories of logicians. The mechanisms present in the minds of children in the first grade are native and uninfluenced by the formal study of logic.

Let us take a few examples of the theory of Reasoning from well known logicians.

MILL AND THE PRINCIPLE OF RESEMBLANCE

For English speaking countries Mill's Logic has been long regarded as a standard. As the result of his analysis he presents finally the following theory of the reasoning process.

"We have obtained thus what we were seeking, an universal type of reasoning process. We find it resolvable in all cases into the following elements: Certain individuals have a given attribute; an individual or individuals resemble the former in certain other attributes; therefore they resemble them also in the given attribute. This type of ratiocination does not claim, like the syllogism, to be conclusive from the mere form of expression; nor can it possibly be so. That one proposition does or does not assert the very fact which was already asserted in another, may appear from the form of expression, that is from a comparison of the language; but that two propositions assert facts which are *bona fide* different, whether the one fact proves the other or not can never appear from the language; but must depend upon other considerations. Whether from the attributes in which Socrates resembles those men who have heretofore died, it is allowed to infer that he resembles them also in being mortal, is a question of induction; and it is to be decided by the principles or canons which we shall hereafter recognize as tests of the correct performance of that great mental operation.

"Meanwhile, however, it is certain, as before remarked, that if this inference can be drawn as to Socrates, it can be drawn as to all others who resemble the observed individuals in the same attributes in which he resembles them, that is (to express the thing concisely) of all men."[1]

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[1] A System of Logic. New York, 1870. Chap. III, pp. 136–137.

Mill puts forward the principle of resemblance to take the place of that of subsumption of a particular case under a universal principle or as he terms it the *dictum de omni et nullo.*

Which of these two principles of reasoning seems to be most common in the first year of school life?

We have found from our analysis of the reasoning of children in the first grade the following mechanisms:

The mechanism of the conditional syllogism, not indeed worked out in detail but implicit in the answers of the children. (First problem.)

The subsumption of a particular act under a general principle. (Second, third and sixth problems.)

The subsumption of a particular individual in a class. (Problems seven and eight—only one child.)

The one child in the first grade who answered questions seven and eight, correctly formulated his answers as follows:

7. "Yes. Because the other ones got black eyes they'll get black eyes."
8. "Yes. One fish has got gills, the other one will have gills."

Could these answers be taken to mean: This tree I am going to plant resembles in various points a great many other trees that grow "buckeyes;" because of this resemblance in other points, it will resemble them also in growing "buckeyes."

The fish in Alaska are like the fish in the rest of the world in a great number of characters; they will, therefore, be like them in having gills.

This would require the child to know a great deal about the characters of horsechestnut trees and the structure of fish of which he is necessarily ignorant.

Less is required of the child's mind if we ask him only to say if *all,* then this one from the group to which "all" refers. This, as we have seen, is formally stated in the second grade and thereafter without any ambiguity. And we find in no case a clear statement of the principle of resemblance.

The principle of subsumption rather than Mill's principle of resemblance is, therefore, the native form that reasoning takes in the human mind.

Mill's principle was formulated, not on the basis of an analysis

of the process of reasoning as it occurs in the child or the adult, but because of his theory that the universal can have no existence. "The class is nothing but the objects contained in it: and the *dictum de omni* merely amounts to the identical proposition that whatever is true of certain objects is true of each of these objects."[2]

The "dictum" is indeed self-evident, but this does not militate against it as a principle of reasoning. The difficulty of reasoning does not lie in the complexity of the fundamental principles on which it is based, but rather in so formulating the data of a concrete problem that one may see clearly that the principle is applicable.

Furthermore, it seems far more natural to conclude that if human beings use universal premises in their reasoning processes, the human mind must be capable of some kind of universal knowledge, than to say, seeing that it is a priori evident that the human mind cannot conceive of the universal, it is, therefore, evident that in its reasoning process it cannot make use of universal principles.

JEVONS AND THE PRINCIPLE OF SUBSTITUTION

Jevons has formulated the theory that in reasoning we have the substitution of one quantity for its equivalent just as in mathematics we substitute for one term in an equation another which we have shown to be its equivalent.

"The one supreme rule of inference consists, as I have said, in the direction to affirm of anything whatever is known of its like, equal or equivalent. The *Substitution of Similars* is a phrase which seems aptly to express the capacity of mutual replacement existing in any two objects which are like or equivalent to a sufficient degree. It is matter for future investigation to ascertain when and for what purpose a degree of similarity less than complete identity is sufficient to warrant substitution. For the present we think only of the exact sameness expressed in the form.

$$A = B$$

"Now if we take the letter C to denote any third conceivable object, and we use the sign $\propto$ in its stated meaning of *indefinite relation*, then the general formula of all inference may be thus exhibited, from

$$A = B \propto C$$

$$A \propto C$$

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[2] A System of Logic, Book II, Chap. II, pp. 117–8.

or in words—*In whatever relation a thing stands to a second thing, in the same relation it stands to the like or equivalent of that second thing.* The identity between A and B allows us indifferently to place A where B was or B where A was; and there is no limit to the variety of special meanings which we can bestow upon the signs used in this formula consistently with its truth. Thus if we first specify only the meaning of the sign $\propto$ we may say that if C is the weight of B, then C is also the weight of A.

"If C is the father of B, C is the father of A.

"If C is the fragment of B, C is the fragment of A.

"If C is the quality of B, C is the quality of A.

"If C is a species of B, C is a species of A.

"If C is the equal of B, C is the equal of A.

and so on ad infinitum."[3]

The theory is ingenious and it might be possible for human beings to reason in the way Jevons has indicated. But do they? There is no evidence in our data that such processes of substitution occur in the child's mind.

It is a theory suggested by the attempt to reduce logic to the simple rigidity of mathematical procedure; but *de facto* mathematical substitutions are not used in the reasoning of children and seldom in that of adults.

BINET AND THE FUSION OF IMAGES

Binet's theory of reasoning as expressed in his little work "La psychologie du raisonnement" (third edition, Paris, 1902) is intimately bound up with his theory of perception. It is typical of an associational theory of reasoning and is here presented as a type.

Every perception, according to Binet, contains an element which is identical with the operation that consists in drawing a conclusion from given premises.[4]

As an example he analyzes the perception of an orange.

Various sensory data are presented to the mind: the visualization of its color, muscular sensations in the eye muscles and also in the musculature of the head and trunk giving information about the size, direction and distance of the object. Besides the immediate sense data one believes that he sees the spherical form, the

[3] Jevons, The Principles of Science. Chapter I.

[4] Cf. op. cit., p. 76.

smooth and dotted surface, the juice that it encloses, the complicated arrangement of its internal parts. One believes that he feels its weight, its consistence, its odor and taste and that he hears its name pronounced. "If one continues to look at the orange he notes the awakening of images relative to its practical handling, the action of cutting with a knife, of bringing it to the mouth—and throwing away the pulp and seeds."[5]

Comparing now perception and reasoning Binet finds the following points of resemblance.

1. Both are forms of indirect and mediate knowledge. If I say "this is an orange," I transcend experience. For sense does not give me the nature of an object.

2. Both acts suppose the existence of anterior intellectual states.

In reasoning that Socrates is mortal the premise all men are mortal must be presupposed. In perceiving that this object is an orange anterior intellectual knowledge of the nature of a premise must be presupposed, e.g. All spherical bodies with a yellow color and a certain size are fruits filled with a sugary juice.

3. In reasoning the premises are unconscious, in perception the memories of past experience are unconscious.

4. All reasoning is the recognition of a resemblance, perception is the recognition of a resemblance between present sensations and a group of past sensations, though this does not involve a voluntary comparison.

What now takes place in perception: In virtue of the law of association by similarity the sensations of perception awaken visual images of similar objects in past experience. These call up images of other sensations and then in virtue of the law of fusion all are welded together in one perceptive act. In this process the memory image is called up and fuses with the present sensations. $(A = B)$ This takes place in virtue of association by similarity. The memory image then calls up invisible elements associated with it in past experience $(B \rightarrow C)$. This takes place in virtue of the law of association by contiguity. And so the invisible attributes of an object are associated with sensation $(A = B) \rightarrow C$. Thus we have the essential nature of reasoning.

[5] Cf. op. cit., p. 77.

"Reasoning is the establishment of an association between two states of consciousness, by means of an intermediate state of consciousness which resembles the first state, which is associated with the second, and which in fusing with the first associates it with the second."

Apart from the fact that this theory leaves out of consideration the essential element of inference, the insight not merely into the fact that it is so but also that it is so *because* of certain truths, the view has no foundations in the data of children's reasonings. We do not find the principle of resemblance formulated in the children's answers. There is no question of fusion of similars in the reasoning of the child, but the inclusion of the individual in the class or the subsumption of a particular case under a general principle.[6]

SUMMARY AND CONCLUSIONS

A triple group of tests were administered to 205 children as a preliminary survey of the possiblity of a reasoning test for the insane that could be standardized in terms of the intelligence of the child.

The three subforms of this test were: (1) a group of simple problems calling for answers and logical reasons, (2) a group of fallacies illustrating the autistic reasoning of the insane, designed to test the tendency of an individual to slip into this type of reasoning, (3) a group of ordinary logical fallacies.

Age and grade norms were presented.

Intercorrelations of the tests involving also mental age indicated more than one general factor or one general factor plus one or more group factors.

The mechanism of reasoning in the first grade was studied in detail and was found to involve the deduction of conclusions from general principles.

[6] Our conclusion that the reasoning process in early school life is essentially subsumptive and syllogistic seems at variance with such work as that of Willis L. Gard (A Preliminary Study of the Psychology of Reasoning, Am. J. of Psychol., 1907, XVIII, pp. 490–504). When we examine the matter more closely it is not surprising that Gard found little evidence of syllogistic procedure in guessing missing digits in a mutilated process of long division.

The power to understand and reject autistic fallacies occurred first in the third grade.

Clear acceptance of the autistic fallacies occurred first in fourth grade and with some frequency in the fifth grade.

This tendency to think autistically is a transitory phenomenon of childhood, for it was not present in our sample of 103 college Freshmen. If it manifests itself in an educated adult, it should be looked upon as a pathological symptom.

It seems that the logical ability to criticize and reject autistic fallacies appears somewhat before the tendency to fall into this type of reasoning.

There seems to be a closer relationship between reasoning and ability to detect logical fallacies than between either of these and ability to detect autistic fallaces.

At the dawn of school life some children are already able to analyze a logical argument and state why it is false.

If an educated adult gets a score below the mean for college Freshmen by three times the standard deviation, it should be looked upon as strong evidence of mental deterioration. This would be approximately: 8 for reasoning, 1 for autistic fallacies, and 2 for logical fallacies.

The relation of the findings to logical theory were discussed and it was found that the ordinary principle of reasoning in the child mind is that of subsumption. There is no evidence of Mill's concept of resemblance, nor Jevon's theory of substitutions, nor for mere association by resemblance and contiguity as put forward by Binet.

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